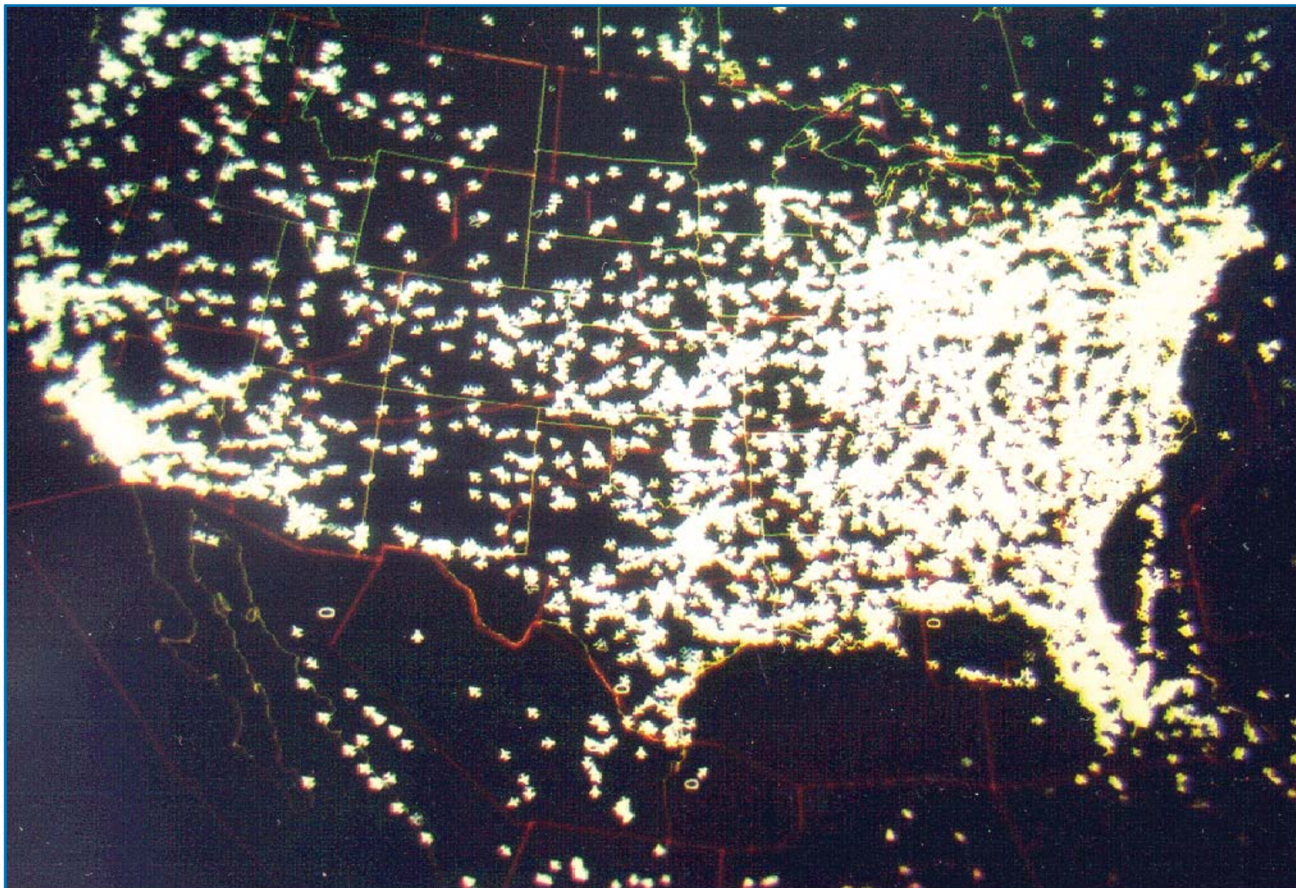


Traffic Situation Display with active national air traffic

2. National Airspace System Modernization

The NAS is among the safest and most secure aviation systems in the world. However, modernization is required for several reasons. First, the move toward Free Flight concepts necessitates equipment with new capabilities and new procedures. The infrastructure must support the unprecedented amount of information being shared between the FAA and NAS users.

Additionally, many current systems are aging. These systems, which have provided years of reliable service, must be maintained to ensure safe operations while also transitioning to future systems. Finally, NAS modernization initiatives leverage technological advances to improve Communications, Navigation, and Surveillance (CNS) and automation systems to support projected air traffic growth.

> "Our job is to ensure that aviation works safely and efficiently. If we do that well, people and cargo get where they need to go, the aviation industry thrives, and the National Airspace System serves us all as the strong and healthy lifeblood of the American economy."
>
> Marion C. Blakey,
> Administrator
> Federal Aviation Administration

The FAA Role in Modernization

The FAA manages the nation's airspace and provides the facilities and services necessary for air commerce. The FAA has established specific goals derived from mission needs.

These goals, identified in the *FAA Strategic Plan*, sustain and upgrade the NAS Architecture in the areas of:

- **Safety:** Reduce fatal aviation accident rates by 80 percent in 10 years;
- **Security:** Prevent security incidents in the aviation system; and
- **System Efficiency:** Provide an aerospace transportation system that meets the needs of users and applies resources efficiently.

FAA MISSION

The FAA provides a safe, secure, and efficient global aerospace system that contributes to national security and the promotion of U.S. aerospace safety.

As the leading authority in the international aerospace community, the FAA is responsive to the dynamic nature of customer needs, economic conditions, and environmental concerns.

The FAA leads, influences, guides, and works with the aviation community to improve the NAS. The aviation community consists of all people and organizations involved in the safe movement of goods and people by aircraft. This includes pilots, controllers, dispatchers, security, mechanics, service personnel, airline companies, passengers, manufacturers, and numerous others in government and private industry.

Concept of the NAS Architecture

The FAA, together with the aviation community, developed the NAS Architecture. Updated by the *NAS Concept of Operations*, December 2000, the NAS Architecture is a 15-year strategic plan that reflects the fundamental organization of the NAS. It includes existing and planned capital investments, their relationships to each other and the environment, and the principles governing their design and evolution.

The NAS Architecture includes the replacement of aging equipment and the introduction of new systems, capabilities, and procedures. It provides a roadmap to increased benefits to all users while increasing safety through new technologies, procedures, and collaboration among users and service providers. The NAS Architecture facilitates continuing dialog on modernization between the FAA and the aviation community.

History of the NAS Architecture

In 1995, the FAA developed the first comprehensive system Architecture for the NAS. The initial NAS Architecture release, Version 1.0, completed in September 1995, was an internal working document developed in parallel with RTCA Task Force 3 on Free Flight. Version 1.0 identified key modernization decisions.

The initial public release of the NAS Architecture Version 1.5, on compact disk only, came in February 1996. This document set forth the concepts and principles of the NAS Architecture and established the direction and methods of the Architecture's evolution.

Major Architecture development continued in 1996 with a focus on resolving several aviation community issues, defining the NAS contents and cost estimates, and developing a transition strategy for NAS Architecture realization. *NAS Architecture Version 2.0*, the first printed version, focused on sustaining existing infrastructure while evolving toward Free Flight. Version 2.0 initiated community-wide discussion about the need for an air traffic services concept of operations for a modernized NAS, aviation community needs, stable funding requirements for the FAA, and the required pace of NAS modernization.

In December 1997, *NAS Architecture Version 3.0* incorporated feedback received from the aviation community and from the air traffic services document, entitled *Concept of Operations for the National Airspace System in 2005*.

In January 1999, *NAS Architecture Version 4.0* was approved by the Administrator. This version incorporated input from the Administrator's Modernization Task Force and more realistic funding profiles for Research, Engineering & Development (R,E&D); Facilities and Equipment (F&E); and Operations. *NAS Architecture Version 4.0*, which covered 1998-2015, was also based on the December 1997 document *Government/Industry Operational Concept for the Evolution of Free Flight*, developed by the RTCA Select Committee on Free Flight Implementation.

The current version of the Architecture is so voluminous that print documents are too cumbersome and static; therefore, the NAS Architecture Database, hosted by the Capability Architecture Tool Suite - Internet (CATS-I), is available via a public Web site. The CATS-I consists of a suite of integrated commercial off-the-shelf (COTS) software products configured with custom applications to provide decision support and systems engineering support necessary to document the NAS Architecture. The CATS-I Web site allows for direct input of comments. Feedback received via the online tool is addressed by the FAA Architecture development team in concert with the aviation community and industry partners.

Structure of the NAS Architecture

NAS Architecture data are divided into programmatic (e.g., costs and schedules) and technical (e.g., concepts, services, capabilities, implementation steps, requirements, and enabling systems) components to meet the FAA mission and to deliver desired services to the aviation community and aviation service providers. Additional information on the programmatic and technical views of the NAS Architecture is available via a tutorial on CATS-I.

Service Hierarchy

The NAS Architecture can be described in terms of a hierarchy of Service Groups, Services, Capabilities, and Implementation Steps as follows:

Service Groups
Service Groups are a collection of related Services. There are six Service Groups used in the NAS Architecture: Air Traffic Services, Safety Services, Certification Services, Airport Management Services, Security Services, and Business Management Services.

Services
Services are high-level activities, performed by the FAA for the aviation community, that contribute to the flow of aircraft throughout the NAS.

Capabilities
Capabilities are functions or related activities that enable or support the delivery of a service.

Implementation Steps
Implementation Steps represent the incremental capability improvements, enabled through the modification or replacement of existing mechanisms or the delivery of new mechanisms, as set in context by operational scenarios.

Implementation Steps can be further broken down into their various components, or *mechanisms*. Mechanisms are the enabling people, support activities, and systems necessary to meet the FAA mission and to deliver desired services to the aviation community. Support activities include procedure development, training, airspace design, certification, standards, and rulemaking. Implementation Steps, together with the scheduled delivery of each incremental capability enhancement, detail the evolutionary plan of the overall Capability.

Modernization Highlights

Several modernization efforts have introduced state-of-the-art equipment into the NAS. Examples include FFP1 and Safe Flight 21 (SF-21). Free Flight Phase 2 (FFP2), recently initiated, will build upon the success of FFP1.

Free Flight Phase 1 (FFP1)

FFP1 resulted from an agreement between the FAA and the aviation community to implement certain highly desired capabilities at selected locations. An important objective of FFP1 was to lessen NAS modernization risks by deploying operational tools at a limited number of sites for performance evaluation. The FFP1 tools include:

- User Request Evaluation Tool (URET) predicts conflicts and helps controllers manage NAS user requests, including altitude, speed, and route change requests, in Kansas City, Memphis, Indianapolis, Cleveland, Chicago, and Washington Air Route Traffic Control Centers (ARTCC). URET is scheduled to be at all En Route centers by 2004.

- Traffic Management Advisor - Single Center (TMA- SC) contributes to fuel savings and reduces delays at Denver, Minneapolis, Fort Worth, Atlanta, Los Angeles, Miami, and Oakland ARTCCs. FFP2 will deploy TMA-SC to additional sites.
- Passive Final Approach Spacing Tool (pFAST) has been returned to research for further development prior to resuming deployment. Center Terminal Radar Approach Control (TRACON) Automation System (CTAS) driven data are being utilized at Southern California TRACON to support situational awareness of traffic flow information.
- FFP1 Surface Movement Advisor (SMA), completed in December 1999, provides real-time Automated Radar Terminal System - Model III (ARTS-III) or Standard Terminal Automation Replacement System (STARS) data about aircraft position and estimated touchdown time in Chicago, Dallas/Fort Worth, Detroit, Newark, Teterboro, and Philadelphia.
- Collaborative Decision Making (CDM), completed ahead of schedule on May 3, 2001, offers real-time access to NAS data for system users including over 30 airlines and NAV CANADA. CDM will be enhanced during FFP2.

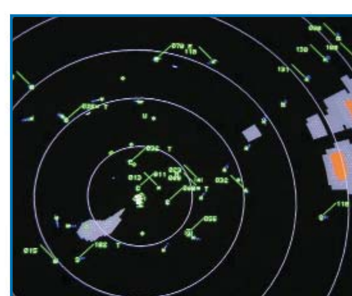
> "The FAA is delivering on its promise to put new equipment into the hands of the controllers."
>
> John Thornton,
> Director
> FAA Free Flight Program

Safe Flight 21 (SF-21)

The SF-21 program demonstrates and validates, in a real-world environment, the capabilities of advanced surveillance systems and air traffic procedures associated with Free Flight, using Automatic Dependent Surveillance - Broadcast (ADS-B) and Traffic Information Services - Broadcast (TIS-B) as enabling technologies. Initiatives are underway in the Ohio River Valley and in the Bethel area of the Alaskan Region (the Capstone program). Results from both the Ohio River Valley and Capstone programs help the FAA validate costs and benefits of ADS-B technologies, and enable the FAA and users to make appropriate investment decisions. The FAA recently announced the selection of an ADS-B architecture that utilizes a combination of the 1090 megahertz (MHz) Extended Squitter ADS-B link for air carrier and private/commercial operators of high-performance airframes, and the Universal Access Transceiver (UAT) ADS-B link for typical general aviation (GA) users.

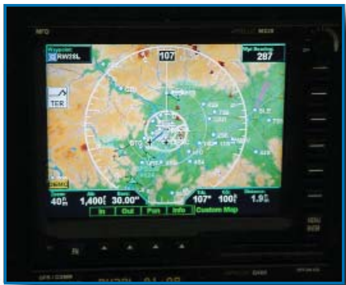
Ohio River Valley

The SF-21 program in the Ohio River Valley provides an operational evaluation of an integrated ADS-B environment that will support Free Flight operational enhancements. Ohio River Valley activities provide improved aviation capabilities for equipped aircraft and vehicles in the evaluation area, and an infrastructure from which to gather data necessary to implement future Architecture programs. Ohio River Valley evaluations provide answers to technical and cost/benefit questions necessary for FAA/industry decisionmakers to make key CNS technology choices. These answers will help the SF-21 program validate the Free Flight operational enhancements.



Ohio River Valley display

Capstone



Capstone display

The SF-21 Capstone initiative ushered in a new era in aviation safety with the use of ADS-B technology. ADS-B-equipped aircraft, in the Bethel area of the Alaskan Region, broadcast their precise position in space via a digital data link to ground-based transceivers. These transceivers forward the information to the Anchorage ARTCC, where the Micro En Route Automated Radar Tracking System (MicroEARTS) supports ADS-B input processing and display, and is shown on controllers' screens. Additional information, including airspeed and altitude and whether the aircraft is turning, climbing, or descending, is also transmitted.

The first phase of Capstone equipped more than 160 aircraft with a certified Global Positioning System (GPS) navigation receiver, a UAT data link, and a multifunction color display. In addition to the avionics suites, Capstone deploys a ground infrastructure for weather observations, data link communications, surveillance, and Flight Information Services (FIS) to improve safety and enable eventual implementation of new procedures. The transmission of weather information to the cockpit is via the same UAT data link that supports ADS-B. The FAA plans to extend Phase I of the Capstone program through December 31, 2004.

> "ADS-B will provide the ground ATC system and ADS-B-equipped aircraft with a common picture of the air traffic situation. RTCA Task Force 3 believed that the common situational awareness would enable greater efficiencies and safety by giving pilots a greater role in the air traffic control process."
>
> John A. Scardina,
> Director
> Office of System Architecture
> and Investment Analysis

The second phase of the Capstone program is about to begin in the southeast portion of Alaska, centered around Juneau, the state capital. Capstone Phase II will include both a multifunction display and an optional highway-in-the-sky display as part of its avionics package. To support the evaluation of Phase II, up to 200 aircraft will be equipped with the necessary Phase II avionics.

The FAA awarded a contract on April 15, 2002, for avionics to support the agency's Capstone Phase II program in Southeast Alaska. The contract is for state-of-the-art avionics systems, installation kits, and databases covering navigation, obstruction, and terrain. In addition, it includes avionics training simulators and training assistance. The avionics, which include a GPS-based primary flight display and a multifunction navigation display, will be furnished by the FAA to GA and commercial air carriers operating fixed-wing and rotary-wing aircraft in the area that voluntarily participate in the Capstone Phase II program test period for up to three years.

Maintaining the Momentum

Free Flight Phase 2 (FFP2)

FFP2 includes the geographic expansion and enhancement of FFP1 capabilities, including CDM, URET, and TMA-SC. Additionally, FFP2 includes Controller-Pilot Data Link Communications (CPDLC).

The desired benefit of CDM/Collaborative Routing Coordination Tools (CRCT) is to change the way air traffic is managed, prompting a shift from current practice, where the FAA is the service provider and is responsible for traffic decisions, to a collaborative paradigm in which users have input on decisions and all parties are simultaneously aware of NAS constraints. FFP2 will deploy CDM with CRCT functionality on the traffic flow management infrastructure to 20 ARTCCs and the Air Traffic Control System Command Center (ATCSCC) by 2005, as well as to participating Airline Operation Centers (AOC).

FFP2-planned URET enhancements include Alternate Flight Plan Processing, Automation Assisted Dynamic Rerouting, processing of International Civil Aviation Organization (ICAO) flight plans, non-radar airspace capability, and technology refresh of processors, routers, local area networks, and operating systems. FFP2 will expand URET to all ARTCC facilities by 2004. TMA-SC enables En Route controllers and traffic management specialists to develop complete arrival-scheduling plans for controlled aircraft. FFP2 will deploy TMA-SC to Houston, Kansas City, Indianapolis, and Memphis centers.

CPDLC provides for the exchange of digital messages between pilots and controllers as an alternative to voice. The benefits of CPDLC include the ability to transmit ATC information in a reliable, uncluttered medium and reduce voice communication flow on ATC radio frequencies.

FFP2 will also facilitate Research & Development (R&D) on certain key technologies. The following R&D projects will be monitored and evaluated for the purpose of making investment decisions in the 2003-2005 timeframe:

- Direct-To (D2) - A tool designed to assist En Route controllers in identifying aircraft that can have their time en route reduced by flying directly to a downstream point closer to the destination airport. D2 also provides conflict probe, trial planning, and flight plan amendment capabilities for En Route R-side controllers.
- Equitable Allocation of Limited Resources (EALR) - A capability that extends the collaborative rerouting process by providing functionality to balance the assignment of entry into a congested airspace with assignment of reroutings. The capability ensures equity within an individual initiative as well as across several days.
- Problem Analysis Resolution and Ranking (PARR) - A set of tools that will assist the En Route controller in managing flight data derived from URET. PARR will assist the controller in developing strategic resolution for aircraft-to-aircraft and aircraft-to-airspace conflicts. The integration of these tools will allow the entire sector team to access the full range of tactical and strategic tools and displays at each position.
- TMA - MultiCenter (TMA-MC) - A decision support tool that builds on TMA-SC to support efficient time-based metering of arrival traffic in arrival airspace spanning multiple centers. Research will provide TMA in the complex Northeast Corridor airspace for four centers that feed Philadelphia.
- Surface Management System (SMS) - A system to reduce arrival and departure delays and inefficiencies that occur on the airport surface due to surface issues and downstream restrictions. SMS is a decision support tool that will help controllers and users of the NAS manage the movement of aircraft on the surface of busy airports, thereby improving capacity, efficiency, flexibility, and safety. SMS will support cooperative planning of other arrival and departure traffic management decision support tools to provide additional benefits.

The following R&D projects will be monitored for acceleration but are not expected to mature during the 2003-2005 timeframe:

- Expedite Departure Path (EDP) - A decision support system designed to assist controllers in TRACONs and ARTCCs with departure-related situations.
- Advanced Vortex Spacing System (AVOSS) - A completed research initiative by the National Aeronautics and Space Administration (NASA) that evaluated a ground-based system to make dynamic spacing recommendations for aircraft arriving in-trail to a runway, using current and projected atmospheric information to model wake vortex behavior. FFP2 is monitoring the work of the wake vortex research community for the possible acceleration of capacity-enhancing wake vortex-related technology.
- En Route/Descent Advisor (E/DA) - A decision support tool for the efficient handling of En Route arrivals. It will have the capability to assist controllers in handling arrival aircraft in the descent phase of the sequencing process.
- Active Final Approach Spacing Tool (aFAST) - A Terminal component of the NASA-developed CTAS that provides not only runway assignment and sequence for arriving aircraft, but also a conflict-free approach path through a series of heading and speed adjustments.